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ADDITIONS TO THE LICHEN FLORA OF ARARACUARA (COLOMBIAN AMAZONIA)

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Resumen

Investigaciones recientes de campo en la vegetación primaria en los alrededores de Araracuara (sector Colombiano de la cuenca Amazónica) demostraron la presencia de una flora liquénica de gran variedad en los bosques y en las sabanas en las mesetas de arenisca. Se presentan 93 especies, principalmente en corteza, suelo y arenisca. En conjunto con las especies anteriormente publicadas, hace un total de 211 especies, cuyo número es probablemente menor que la mitad de la flora actual.

Palabras clave: Liquen, Flora, Araracuara, Colombia

Abstract

Recent fieldwork in the primary vegetation around Araracuara (Colombian sector of Amazon Basin) showed the presence of a varied lichen flora in the forests and the savannahs on the sandstone table land. Here 93 species are recorded, mainly growing on tree bark, rock and soil, raising the total number of known species from the area to 211. In spite of these additions the lichen flora is still supposed to be less than half-way known.

Key words: Lichen, Flora, Araracuara, Colombia

Introduction

The Amazon basin is well-known as the world's largest continuous area of humid tropical lowland forest, with a long geological history. Accordingly its flora and fauna are very diverse and it constitutes one of the world's most important centres of biodiversity. For a long time it has been unclear whether this is also true for lichens. Recent investigations have shown that tropical lowland forests are an important diversity centre for lichens (Gradstein 1992), and several of the principal groups of lichens appear to be concentrated in tropical lowlands (Aptroot & Sipman, in press). Consequently, Araracuara with its surroundings, situated in the Amazon basin and with a wide range of primary vegetation types, is a very promising place to investigate lichen diversity.

The first botanical exploration in Araracuara was remarkably early, already in the beginning of the last century (cf. Martius 1828). However, little attention was paid to lichens by then, and serious investigation of the lichen flora started only through the activities of the Corporación Colombiana para la Amazonia-Araracuara. Phytosociological investigations around 1990 by A. M. Cleef and J. Duivenvoorden (Duivenvoorden & Cleef 1994) showed that a varied terricolous lichen flora was present on the tablelands. Information on the epiphytic lichen flora became available through field work by the author in 1988 (Sipman 1990).

The vegetation of the investigation area ranges from tall rain forest along the streams and on well-drained plains, to low and open forest in swamps and on quartzite plateau's. Locally the forest is interrupted by bare rock flats and exposed or shaded rock outcrops and escarpments. Consequently a wide range of lichen habitats is available: foliicolous in forest undergrowth and in more open spots, corticolous in the shade of the lower forest levels and in the lighter and more open situation of the canopy and in scrub; saxicolous on shaded or well-lit quartzite rocks; and terricolous on acid, sandy or humous soil. The most species-rich of these habitats are probably the leaves of the forest undergrowth (cf. Sipman 1990) and branches of the canopy (cf. Montfoort & Ek 1990).

Methods

From 29 October to 3 November 1988 a lichen survey was made by H. Sipman and J. Duivenvoorden, accompanied by A. Jaramillo, R. Hofstede and J. Wolf. For details see also Sipman (1990). The following habitats were visited: high forest; low forest on rocky soil; open forest on oligotrophic swampy soil; rock flats; secondary vegetation. Usually only specimens within reach from the ground were studied. Occasionally canopy branches were available for study. Samples were collected from as many lichens as possible and studied with the usual means. The first set of these samples is deposited in the Herbario Amazonico, a large set of duplicates in B. Identifications are by the author. A literature search was made for additional reports.

Results

The 1988 field work resulted in a total of 823 collected specimens. Of these 609 could be identified to species level. They appeared to belong to some 210 species in over 90 genera; 214 collections are provisionally identified or left unidentified for various reasons, such as poor taxonomic knowledge of the group or poor quality of the specimen. Three additional species were found in the literature.

The high identification rate is caused to some extent by selective collecting: crustose specimens were usually not collected when no ascocarps could be observed in the field. Such «sterile crustose» lichens are impossible to identify with the usual keys based on ascocarp features. However, they are quite common and make out an important part of the lichen vegetation on tree trunks.

The results of the foliicolous lichens have already been published before (Sipman 1990). In addition, *Mycomicrothelia hemispherica* and *M. thelena* were published by Aptroot (1991: 131) and *Cladonia carassensis* by Sipman (1993: 306). Several specimens were included in publications of new species: *Buellia bellardii* (Sipman 1992: 19), *Bulbothrix leprieurii* (Sipman & van Aubel 1992: 2), *Byssoloma farkasii* (Sipman & Aptroot 1992: 98), *Ocellularia sinuosa* (Sipman 1992: 30), *Parmotrema aptrootii* (Sipman & van Aubel 1992: 3), *Parmotrema aurantiacoparvum* (Sipman & van Aubel 1992: 4), *Porina epilucida* Sipman (Aptroot & Sipman 1994: 21) and *Thelotrema albomaculatum* (Sipman & Aptroot 1992: 89).

In the literature 16 records basing on other collections were found. The visit by Martius resulted in the report of *Pseudocyphellaria aurata* (Martius 1828: 24, Eschweiler 1833: 216), here considered as a misidentification, see note below. Ahti reported *Cladonia pulviniformis* (1990: 264) and *C. spinea* (1986: 217), both collected by H. W. Woolhouse in 1977. Several terricolous lichens were reported by Duivenvoorden & Cleef (1994), basing on their fieldwork: *Cladia aggregata*, *Cladina sprucei*, *Cladonia carassensis*, *C. corallifera*, *C. crassiuscula*, *C. didyma*, *C. furfuracea*, *C. peltastica*, *C. pulviniformis*, *C. secundana*, *C. signata*, *C. spinea*, *C. vareschii*, *C. variegata*, *Siphula carassana* and *S. decumbens*.

Additional species from the collections by Sipman & Duivenvoorden are presented below. For all available specimens the collection numbers are given, under which they can be found in the Herbario Amazonico. The numbers in brackets refer to the localities, which are listed below and contain habitat information.

Arthonia orbignyae (Upadhyay) Matzer - (1) *27775*; (6) *28033*; (9) *28248*; (12) *28556*. Foliicolous, not reported by Sipman (1990).

Astrothelium cinnamomeum (Eschw.) Müll Arg. - (6) *28078*. Corticolous.

Astrothelium confusum Müll. Arg. - (5) *27864*. Corticolous.

Astrothelium galbineum Kremp. - (5) *27863*; (6) *27908*. Corticolous.

Astrothelium gigasporum Harris - (12) *28445*, *28498*. Corticolous.

Astrothelium subfuscum Kremp. - (12) *28502*. Corticolous.

Biatora pyrrhomelaena Tuck. - (6) *27932*; (9) 28318. Corticolous. The second specimen is identified with hesitation, it is sorediate.

Buellia coccinea (Fée) Aptroot - (3) *27824*. Corticolous.

Bulbothrix fungicola (Lynge) Hale - (11) *28393*. Corticolous.

Bulbothrix goebelii (Zenk.) Hale - (8) *28172*. Corticolous.

Byssoloma amazonicum Kalb & Vezda - (1) *27742*; (6) *27994*; (9) *28202*. Foliicolous, not reported by Sipman (1990).

Byssoloma minutissimum Kalb & Vezda - (7) *28095*; (9) *28205*, *28230*, *28231*; (12) 28523. Foliicolous, not reported by Sipman (1990).

Canoparmelia amazonica (Nyl.) Elix & Hale - (5) *27862*. Corticolous.

Celothelium dominicanum (Vain.) Aguirre - (3) *27837*. Corticolous.

Chiodecton sphaerale Ach. - (8) *28138*. Corticolous.

Chroodiscus neotropicus Kalb & Vezda - (10) 28374. Foliicolous. Included in Sipman 1990: 63 as «ined.».

Cladonia polyscypha Ahti & Xavier Filho - (5) *27896*. On humous soil.

Coccocarpia domingensis Vainio - (6) *28081*; (11) *28397*. Corticolous.

Coccocarpia erythroxyli (Spreng.) Swinscow & Krog - (8) *28168*; (11) *28424*. Corticolous.

Coccocarpia imbricascens Nyl. - (8) *28170*; (10) *28357*, *28359*; (11) *28396*; (12) *28449*. Corticolous. Specimens 28359 and 28449 contain an orange pigment on the lower side, probably the same pigment as in *C. erythrocardia* (Müll. Arg.) Arvidss.

Coccocarpia palmicola (Spreng.) Arvidss. & Gallow. - (8) *28169*. Corticolous.

Coenogonium implexum Nyl. - (6) *28003*. Corticolous.

Coenogonium leprieurii (Mont.) Nyl. - (4) *27840*, *27841*; (6) *27935*, *28002*; (7) *28089*; (11) *28400*. Corticolous.

Crocynia gossypina (Sw.) Massal. - (12) *28471*. Corticolous.

Crocynia pyxinoides Nyl. - (6) *28077*; (8) *28142*. Corticolous.

Dictyonema glabratum (Spreng.) D. Hawksw. - (8) *28143*. Corticolous.

Dictyonema sericeum (Sw.) Berkh. - (5) *27857*; (8) *28144*, *28161*; (11) *28399*, *28401*; (12) *28483*, *28484*. Corticolous.

Dimelaena diffractella (Müll. Arg.) Sheard - (5) *27873*. On sandstone.

Eschatogonia prolifera (Mont.) R. Sant. in Swinsc. & Krog - (6) *27920*; (9) *28317*; (12) *28473*. Corticolous.

Fellhanera bouteillei (Desm.) Vezda - (1) 27761. Foliicolous, not reported by Sipman (1990).

Graphina incrustans (Fée) Müll. Arg. - (9) *28322*; (12) *28458*. Corticolous.

Graphina insculpta (Eschw.) Müll. Arg. - (12) *28436*. Corticolous.

Graphina marcescens (Fée) Müll. Arg. - (6) *27922*, *27930*. Corticolous.

Graphis afzelii Ach. - (3) 27839. Corticolous.

Graphis dumastii (Fée) Spreng. - (1) *27699*; (9) *28321*. The species has been used here in a wide sence, with disregard of chemical differences. Corticolous.

Graphis flexibilis Kremp. - (6) *28073*, *28075*; (11) *28427*. Corticolous.

Graphis grammitis Fée - (6) *27905*; (9) *28306*. Corticolous.

Gyalidea epiphylla Vezda - (7) *28105*. Foliicolous, not reported by Sipman (1990).

«*Lecidea*» *leucophyllina* Nyl. - (5) *27851*. Corticolous. The species has been attributed to the genus *Lecidea* in a wide sense.

Mazosia bambusae (Vainio) R. Sant. - (1) *27771*; (6) *28028*; (7) *28111*; (9) *28243*; (10) *28382*; (12) *28551*. Foliicolous. Reported before by Sipman (1990: 62) as *M. pseudobambusae*.

Mazosia dispersa (Hedrick) R. Sant. - (1) *27768*; (6) *28025*; (9) *28240*; (10) *28380*; (11) *28412*; (12) *28547*. Foliicolous, not reported by Sipman (1990).

Megalospora tuberculosa (Fée) Sipman - (8) *28146*; (11) *28430*; (12) *28461*. Corticolous.

Myriotrema calvescens (Fée) Hale - (1) *27697*; (6) *27957*; (9) *28286*, *28290*. Corticolous. The identification is uncertain.

Myriotrema myriocarpum (Fée) Hale - (12) *28460*. Corticolous.

Myriotrema myrioporum (Tuck.) Hale - (5) *27870*; (12) *28494*. Corticolous.

Myriotrema protocetraricum (Hale) Hale - (6) *27953*, *27954*; (9) *28289*, *28298*, *28299*; (13) *28584*. Corticolous. TLC: protocetraric acid.

Myriotrema subwrightii (Hale) Hale - (13) *28587*. Corticolous. TLC: psoromic acid.

Ocellularia amplior (Nyl.) Redgr. - (8) *28149*; (9) *28330*; (11) *28417*; (12) *28490*. Corticolous. TLC: protocetraric acid; in the thallus of nr. 28490 protocetraric acid could not be demonstrated.

Ocellularia auberiana (Mont.) Hale - (1) *27715*; (6) *27919*. Corticolous. TLC: psoromic acid.

Ocellularia cavata (Ach.) Müll. Arg. - (12) *28470*. Corticolous. TLC: unknown substances («cinchonarum unknown»).The specimen lacks the usual, yellow pigment. Another specimen of this locality, nr. 28469, deviates by the presence of a pinkish pigment in the medulla.

Ocellularia comparabilis (Kremp.) Müll. Arg. - (1) *27705*, *27708*, *27716*; (6) *27945*, *27947*; (12) *28459*, *28464*; (13) *28582*. Corticolous. TLC: psoromic acid. The material is very variable and the determination is somewhat uncertain; there may be more than one species included.

Ocellularia crocea (Kremp.) v. Overeem - (6) *27903*, *27926*. Corticolous. TLC: unidentified pigment.

Ocellularia lepadinoides (Leight.) A. Zahlbr. - (9) *28288*, *28331*; (10) *28354*, *28356*; (12) *28439*, *28440*, *28462*, *28496*. Corticolous. TLC: protocetraric acid.

Ocellularia papillata (Leight.) A. Zahlbr. - (6) *27961*, *27962*; (9) *28283*, *28284*, *28287*, *28296*, *28301*. Corticolous. TLC: no identifiable substances.

Ocellularia perforata (Leight.) Müll. Arg. - (1) *27696*, *27713*; (6) *27916*, *27943*, *27944*, *27946*, *27948*, *27949*, *27955*, *27956*, *27959*, *27963*; (9) *28285*, *28291*, *28292*, *28293*, *28294*, 28297, *28302*; (12) *28442*, *28488*, *28500*; (13) *28580*, *28585*; *28590*. Corticolous. TLC: protocetraric acid.

Ocellularia recondita (Stirt.) A. Zahlbr. - (9) *28295*; (13) *28588*. Corticolous.

Ocellularia rhodostroma (Mont.) Zahlbr. - (8) *28141*. Corticolous. The specimen lacks ascomata and was identified by its chemistry and the presence of the characteristic, glossy isidia.

Parmotrema blanchetii (Hue) Hale - (5) *27877*, *27878*. On sandstone. TLC: atranorin, usnic and protocetraric acids.

Parmotrema cristiferum (Tayl.) Hale - (11) *28432*; (12) *28485*. Corticolous. TLC: atranorin and salazinic acid.

Parmotrema flavotinctum (Hale) Hale - (11) *28434*. Corticolous. TLC: atranorin and unidentified substance.

Parmotrema sulphuratum (Nees) Hale - (8) *28176*. Corticolous. TLC: atranorin, vulpinic acid.

Phaeographina caesiopruinosa (Fée) Müll. Arg. - (6) *27901*; (9) *28345*; (11) *28422*. Corticolous.

Phaeographina chrysocarpa (Raddi) Redgr. - (3) *27820*. Corticolous. No spores seen.

Phylloblastia amazonica Kalb & Vezda - (6) *28041*; (7) *28120*; (9) *28254*. Foliicolous. Cited by Sipman (1990: 63) as *Pocsia sp.*

Phyllopsora buettneri (Müll. Arg.) A. Zahlbr. - (5) *27871*. Corticolous. The chemistry of the material has not been investigated, therefore the subspecies could not be established.

Physcidia wrightii Tuck. - (5) *27850*. Corticolous.

Polymeridium albidum (Müll. Arg.) Harris - (5) *27858*. Corticolous.

Polymeridium subcinereum (Nyl.) Harris - (6) *27904*; (9) *28327*. Corticolous.

Porina exasperatula Vain. - (9) *28281*. Corticolous.

Porina fusca Lücking - (1) *27783*, *27784*. Foliicolous, not reported by Sipman (1990).

Porina lucida R. Sant. - (7) *28121a*. Foliicolous, not reported by Sipman (1990).

Porina mastoidea (Ach.) Müll. Arg. - (7) *28085*; (8) *28147*, *28148*. Corticolous.

Porina rugosa Vezda - (6) *28048*; (7) *28128*. Foliicolous. Already reported by Sipman (1990: 63) as «ined.».

Porina tetracerae (Afz. in Ach.) Müll. Arg. - (1) *27694*; *27714*; (6) *27913*; (9) *28282*. Corticolous.

Pseudoparmelia chapadensis (Lynge) Hale - (2) *27815*. On sandstone. TLC: unidentified pigment.

Pyrenula anomala (Ach.) Vainio - (9) *28313*, *28314*; (10) *28362*. Corticolous. The spores in the available specimens measure 12-15 x 4-6 µm and are thus considerably smaller than indicated by Harris (1989: 85). Therefore their identity is somewhat uncertain.

Pyrenula marginata Hook. in Kunth - (12) *28492*. Corticolous.

Pyxine obscurascens Malme - (5) *27875*. On sandstone.

Sarcographa leprieurii (Mont.) Müll. Arg. - (3) *27822*. Corticolous.

Squamacidia janeirensis var. *endococcinea* (A. Zahlbr.) Brako - (10) *28355*. Corticolous.

Thelotrema dissutum (Hale) Hale - (1) *27702*; (6) *27917*, *27939*; (9) *28311*, *28312*. Corticolous. TLC: no identifiable substances.

Thelotrema refertum (Hale) Hale - (1) *27703*; (6) *27918*, *27924*, *28072*; (10) *28358*; (11) *28428*; (12) *28451*, *28465* cf., *28491*. Corticolous. TLC: hypoprotocetraric acid.

Tricharia vainioi R. Sant. - (1) *27790*; (6) *28058*; (7) *28132*; (9) *28268*; (12) *28573*. Foliicolous. The specimens differs from the description by Santesson (1952: 328) slightly by the frequently pale colour of the apothecia; moreover Santesson (*l.c.*) does not report this species from the Neotropics. Reported by Sipman (1990: 63) as *T.* cf. *carnea* (Müll. Arg.) R. Sant.

Tricharia helminthospora R. Sant. - (6) *28063*; (9) *28270*. Foliicolous, not reported by Sipman (1990).

Trichothelium epiphyllum var. *minutum* Lücking - (1) *27793*. Foliicolous, not reported by Sipman (1990).

Trypethelium aeneum (Eschw.) Zahlbr. - (3) *27828*; (5) *27869*; (6) *27898*. Corticolous.

Trypethelium eluteriae Spreng. - (5) *27866*; (9) *28338*. Corticolous.

Trypethelium infuscatulum Müll. Arg. - (6) *27907*. Corticolous.

Trypethelium nitidiusculum (Nyl.) Harris - (1) *27709*, (3) *27825*; (6) *27931*, *28076*; (8) *28163*. Corticolous.

Trypethelium ochroleucum (Eschw.) Nyl. - (3) *27827*, *27834*; (5) *27868*; (9) *28335*, *28336*, *28340*; (11) *28423*. Corticolous.

Tylophoron protrudens Nyl. - (1) *27692*. Corticolous.

Usnea baileyi (Stirt.) A. Zahlbr. - (5) *27856*. Corticolous. TLC: usnic, norstictic and diffractaic acids.

Xanthoparmelia substenophyllodes Hale - (2) *27817*. On sandstone. The identification is somewhat uncertain because the specimen is very small and the result of the TLC analysis was unclear.

The following literature records appeared to be incorrect.

Bacidia consimilis (Müll. Arg.) R. Sant. (Sipman 1990: 62) is based on misidentification.

Leprocollema sp.? (Sipman 1990: 63) is based on misinterpretation of the genus.

Mazosia pseudobambusae Kalb & Vezda (Sipman 1990: 62) is based on misidentification of *M. bambusae*.

Pocsia sp. (Sipman 1990: 63) is based on material belonging to the recently described *Phylloblastia amazonica*.

Pseudocyphellaria aurata (Ach.) Vain. (Martius 1828: 24, as *Parmelia*; Eschweiler in Martius 1833: 216, as *Parmelia*). Occurrence of this species is very unlikely at such a low elevation in the tropics. The spore description of Eschweiler (simple) also indicates that it concerns a misidentification. Very likely it concerns *Parmotrema sulphuratum*, which has simple spores and a superficial resemblance with *Ps. aurata* because of its yellow medulla.

The collecting localities

(1) 29 Oct. 1988. Dept. CAQUETA. Araracuara, tableland near airstrip. Alt. 350 m. Co-ord. 0°36' S, 72°26' W. Along trail from road Araracuara-Puerto Arturo to Cueva de Guacharos, in low forest on podsolized soil/ in forest on steep slope towards river Caquetá.

(2) 29 Oct. 1988. Dept. CAQUETA. Araracuara, tableland near airstrip. Alt. 350 m. Co-ord. 0°36' S, 72°26' W. Sandstone plates in savannah between airstrip and Balcon del Diablo.

(3) 29 Oct. 1988. Dept. CAQUETA. Araracuara, along road to airstrip. Alt. 300 m. Co-ord. 0°36' S, 72°26' W. Epiphyte on small tree in secondary vegetation and gardens.

(4) 30 Oct. 1988. Comisaría AMAZONAS. Araracuara, tableland on S-side of river Caquetá W of Puerto Santander, opposite airstrip of Araracuara. Alt. 300 m. Co-ord. 0°36' S, 72°24' W. Tall forest on slopes W of Puerto Santander.

(5) 30 Oct. 1988. Comisaría AMAZONAS. Araracuara, tableland on S-side of river Caquetá W of Puerto Santander, opposite airstrip of Araracuara. Alt. 350 m. Co-ord. 0°36' S, 72°25' W. Sandstone plates with low savannah forest, «Ciudad Perdida» 1 km W of Chorro de Araracuara.

(6) 31 Oct. 1988. Dept. CAQUETA. 2.5 km NE of Araracuara. Alt. 250 m. Co-ord. 0°37' S, 72°23' W. c. 30 m tall, hardly disturbed forest on Low Terrace of river Caquetá («parcelas de Marcela Torres»).

(7) 1 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. Isla Mariñame in river Caquetá. Alt. 240 m. Co-ord. 0°45' S, 72°06' W. Primary forest near river.

(8) 1 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. Isla Mariñame in river Caquetá. Alt. 240 m. Co-ord. 0°45' S, 72°06' W. Swamp with *Mauritia flexuosa* and little trees, c. 1.5 km S of the river.

(9) 2 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite Isla Mariñame. Along trail to «Pantano de Monica Sosa». Alt. c. 240 m. Co-ord. 0°42' S, 72°07' W. c. 30 m tall primary forest on Low Terrace of river Caquetá, close to the river.

(10) 2 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite Isla Mariñame. Along trail to «Pantano de Monica Sosa», about halfway. Alt. c. 240 m. Co-ord. 0°42' S, 72°07' W. c. 10 m tall, light forest, dominated by *Euterpe precatoria* (Chuqueal) on boggy soil.

(11) 2 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite Isla Mariñame. «Pantano de Monica Sosa». Alt. c. 240 m. Co-ord. 0°42' S, 72°07' W. c. 6 m tall, light forest, dominated by small *Clusia* and Bombacaceae, on peat, 4 km N of the river.

(12) 3 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite E-end of Isla Morrocoy. Alt. c. 300 m. Co-ord. 0°36' S, 72°10' W. c. 10 m tall, light savannaforest on podsolized soil with peaty top layer, on Tertiary sediments, 2 km N of the river.

(13) 3 Nov. 1988. Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite E-end of Isla Morrocoy. Alt. c. 250 m. Co-ord. 0°36' S, 72°10' W. c. 30 m tall, primary forest on steep slope near river.

Conclusions

The present list, together with the published information, gives a total of 211 fully identified lichen species for Araracuara and surroundings. These include about 90 foliicolous taxa, a similar number of corticolous taxa, about 20 terricolous taxa, and a few saxicolous taxa.

A comparison with published lichen lists from comparable areas in Venezuela and Guyana (Sipman 1992, Sipman & Aptroot 1992) shows that more foliicolous species are known from Araracuara, but less corticolous species. There seems to be no reason to assume that the lichen flora of these areas is really different, and the most likely explication is that the corticolous lichen flora of Araracuara is more incompletely known. This is plausible in view of the limited time available for fieldwork and, more important, the difficulty to explore the most important habitat, the canopy.

A need for additional study of the lichen flora is documented by results from foliicolous lichens. The 1989 investigations lead to the conclusion that the forests near Araracuara, with about 90 species in one of the plots, had the richest foliicolous lichen flora reported in the world (Sipman 1990). In the meantime research in Costa Rica (Lücking 1994) has show the existence of a similar plot with 177 species, after a more intense examination, spread over about four months, while Sipman (in press) found 155 species in a forest in southern Guyana. Therefore it is quite probable that an extended search on the sites of Araracuara will reveal the presence of a comparable high number of species. This is suggested by the fact that already 12 foliicolous taxa additional to the 1990 list have been recognised.

Summarising, the principal conclusion is that the current knowledge of the lichen flora of Araracuara is still far from complete. Even in the best-known group, the foliicolous lichens, many additions can be expected, and as to the corticolous lichens, very probably less than half of the available flora is known. In view of this incomplete knowledge, any conclusions about geographical relations, degree of species richness, or differences between vegetation types would be premature.

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Literature cited

Ahti, T. 1986. New species and nomenclatural combinations in the lichen genus *Cladonia*. Ann. Bot. Fennici 23: 205-220.

Ahti, T. 1990. New species of *Cladonia* from tropical South America. Lichenologist 22(3): 261-268.

Aptroot, A. 1991. A monograph of the Pyrenulaceae (excluding *Anthracothecium* and *Pyrenula*) and the Requienellaceae, with notes on the Pleomassariaceae, the Trypetheliaceae and *Mycomicrothelia* (Lichenized and Non-lichenized Ascomycetes). Bibliotheca Lichenologica 44, 178 pp.

Aptroot, A. & H.J.M. Sipman. 1994 («1993»). Trichotheliaceae (Lichens), pp. 1-57 in: A.R.A. Görts-van Rijn (ed.), Flora of the Guianas Ser. E, Fasc. 2.

Aptroot, A & H. Sipman (in press). Diversity aspects of lichenized fungi in the tropics, in: K. D. Hyde (ed.), Diversity of tropical microfungi. Hong Kong, University Press.

Duivenvoorden, J.F. & A.M. Cleef. 1994. Amazonian savanna vegetation on the sandstone plateau near Araracuara, Colombia. Phytocoenologia 24: 197-232.

Eschweiler, F. 1833. Lichenes, in: Martius, Flora Brasiliensis seu Enumeratio Plantarum 1(1): 51-293.

Gradstein, S.R. 1992. The vanishing tropical rain forest as an environment for bryophytes and lichens, pp. 234-258 in: J.W. Bates & A.M. Farmer (eds.), Bryophytes and Lichens in a Changing Environment. Clarendon Press, Oxford.

Harris, R.C. 1989. A sketch of the family Pyrenulaceae (Melanommatales) in Eastern North America. Mem. New York Bot. Garden 49: 74-107.

Lücking, R. 1994. Foliikole Flechten und ihre Mikrohabitatpräferenzen in einem tropischen Regenwald in Costa Rica. Thesis Ulm, Germany, 203 pp.

Martius, C.F.Ph. von. 1828. Lichenes in Icones selectae plantarum cryptogamarum, quas in itinere annis MDCCCXVII-MDCCCXX per Brasiliam ... collegit et descripsit: 9-30, T. 6-13 (München).

MONTFOORT, D. & R.C. EK. 1990. Vertical distribution and ecology of epiphytic bryophytes and lichens in a lowland rain forest in French Guiana. Institute of Systematic Botany, Utrecht, 60 pp.

SIPMAN, H. 1990. Colección preliminar de líquenes sobre hojas en Araracuara, Colombia. Colombia Amazonica 4(2): 59-65.

SIPMAN, H.J.M. 1991. Notes on the lichen flora of the Guianas, a neotropical lowlan area, pp. 135-150 in: D.J. Galloway (ed.), Tropical Lichens: Their Systematics, Conservation, and Ecology. Systematics Association Special Volume 43. Clarendon Press, Oxford.

SIPMAN, H.J.M. 1992. Results of a lichenological and bryological exploration of Cerro Guaiquinima (Guayana Highland, Venezuela). Tropical Bryology 6: 1-31.

SIPMAN, H.J.M. & A. APTROOT. 1992. Results of a botanical expedition to Mount Roraima, Guyana. II. Lichens. Tropical Bryology 5: 79-107.

SIPMAN, H. & R.J.M.T. VAN AUBEL. 1992. New Parmeliaceae (Lichenes) from the Guianas and surroundings. Mycotaxon 44: 1-12.

SIPMAN, H.J.M. 1993. Lichenotheca Latinoamericana a museo botanico berolinensi edita, fasciculum secundum. Willdenowia 23: 305-314.

SIPMAN, H. J. M. (in press). Observations on the foliicolous lichen and bryophyte flora in the canopy of a semi-deciduous tropical forest. in: E. Farkas & T. Pocs (ed.), Cryptogams in the phyllosphere: systematics, distribution, ecology and use. Estzerhazy Teachers College, Eger.